Autonomous Solar Powered Suborbital Satellite

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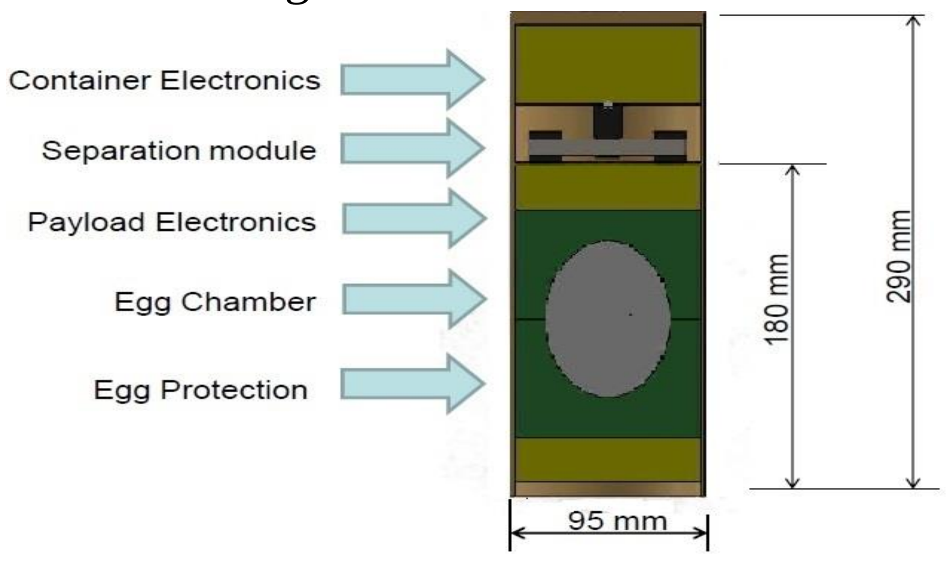
Abstract

We are going to Launch an autonomous CanSat that consists of a container and a payload. The payload will deploy from the container and will gently descend and safely land one raw hen egg. CanSat will be launched in a rocket then deployed from it at an altitude of about 670 meters or higher. Upon deployment from rocket, container and payload shall descend at 12 meters per second using any passive descent control system. At an altitude of 500 meters, the payload shall be released from the container. Payload will free fall with a descent rate of 10 meters per second or less. Temperature and pressure data will be collected every second in each of the payload and container. Power must be harnessed from the environment. Thin sheets of solar cells will be used to harvest energy. A three-axis accelerometer will be used to measure the stability and angle of descent of the payload during descent. Data will be sent from the transmitter in bursts and retrieved at the ground station through a transceiver. All data will be displayed in real time and saved on a computer in the ground station.

Model Design

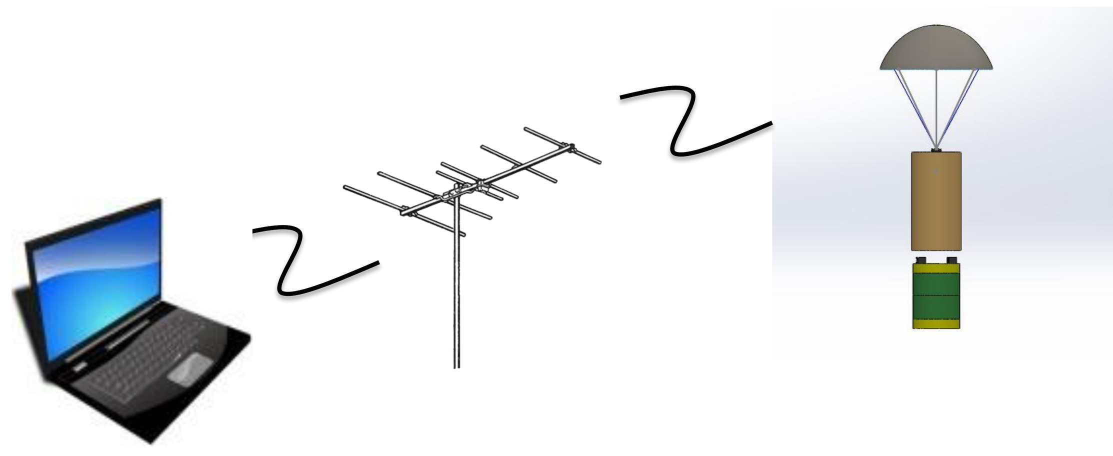
The CanSat has to fit inside a 125mm x 310mm envelope which has to also include a passive decent control system. It is inserted into the launch vehicle in a Container-Payload configuration. This allows the CanSat to drop out in proper orientation. The container has all the electronics. The payload has the egg and the electronics necessary for data collection. It is released when the rocket reaches its apogee. The body skeleton of the container is made of plastic. Sensors are placed appropriately inside the container and the payload optimizing the space available and increasing the functionalities.



The egg has to be protected from cracking or breaking during flight until landing. The various egg protection materials are high density foam, bubble wrap, Corn starch, Peanut butter, various polymer based compounds. It will be surrounded by one step foam and placed in a chamber.

Sensors, Communications and power

Three sensors were used in each of the payload and container. Pressure sensor, BMP 180, was used to measure the altitude. Temperature sensor, TMP 36 was used to collect temperature data. And for the Accelerometer, ADXL 377 was used, which is able to support 200 Gs force of acceleration. ATmega32U4 processors in the Container and Payload will packetize telemetry data for transmission via the XBEE Pro 900MHz radios. Transceiver XBEE Pro 900 MHz in the ground station will process received data packets and pass them to the computer via RS485 protocol which has an advantage of making Long range ground coverage possible. Custom made Ground station software will display data in real time and Store it in a computer. Telemetry data will be sent with ASCII comma in this format, <TEAM ID> ,<PACKET COUNT>, <MISSION_TIME> ,<ALT SENSOR>,<TEMP>,<VOLTAGE>



All components require 3.3 volts. Both in the container and the payload they use 3.3V of energy. The container has an external power source which is a 9V battery. The payload harvests energy while it's descending from the underlined sheets of solar cells.

Mass Budget:
The total mass of the Container was estimated to be 240 grams where as the payload's mass will be around 265 grams. Which means the total mass of our CanSat design rounds up to 505 grams.

Parachute Design

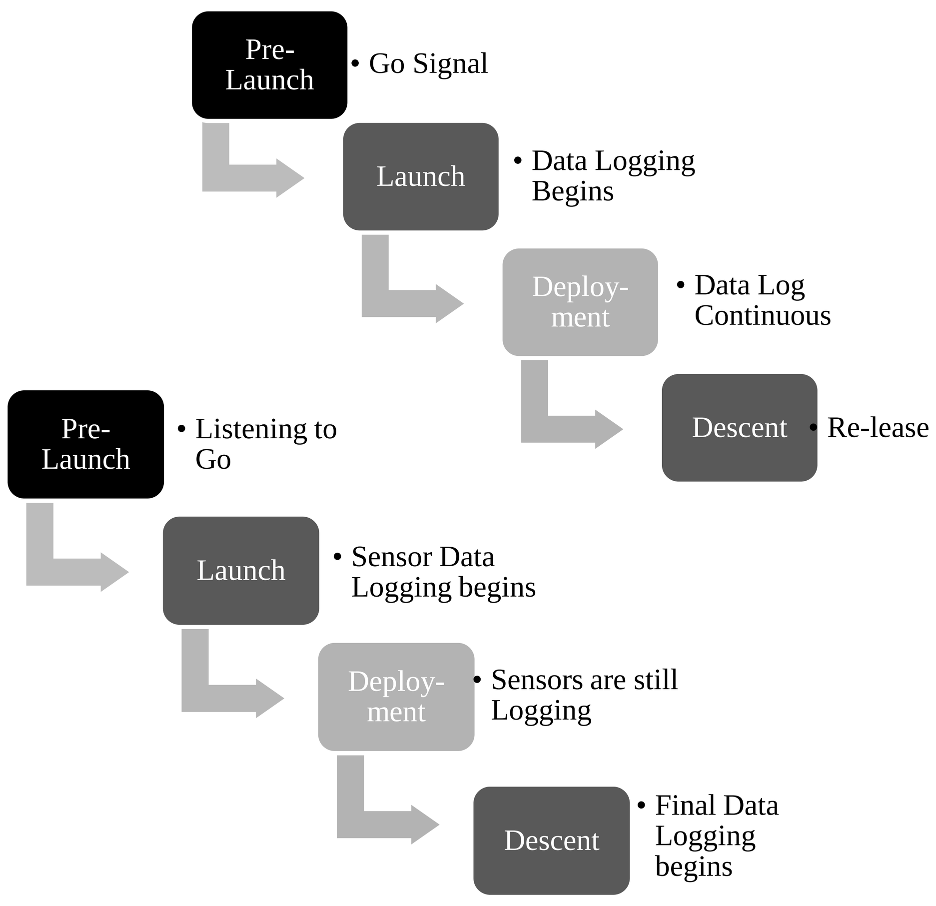
While the payload is still in the CanSat, the parachute will be closed such as to occupy an allotted space. To attain greater stability and a descent rate of 12 m/s, a spill hole of around 2-3 cm is provided at the top of the parachute.

The area of the parachute required is estimated to be **0.242 squared meters.**

Nylon was chosen as the best parachute material, and the shape of the parachute will be hexagonal since the coefficient of drag is agreeable to the decent rate required.

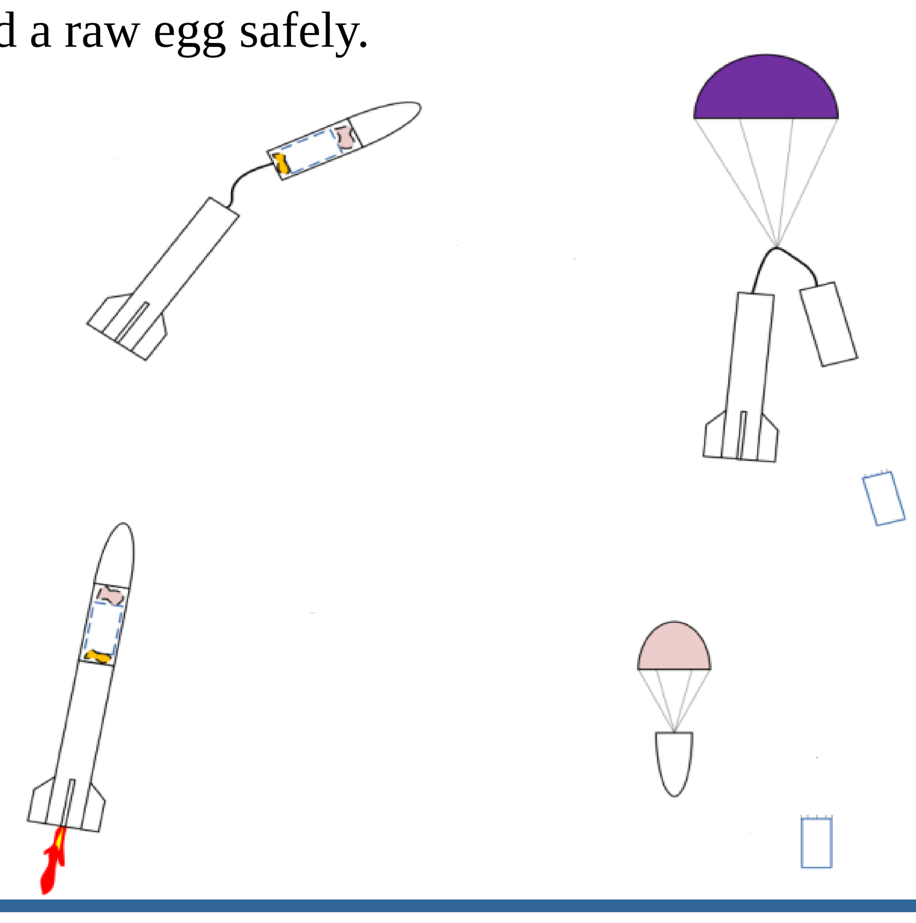
Flight Software

FSW is the same for both the Container and Payload. Both will function separately but the code running will be executing the same functions on both. FSW will be written for the Atmel XMEGA processor using C programming language. The Container FSW states are: Pre-Launch where Container listens for "Go" signal from ground station. Launch; Container polls sensor packages, pressure altitude, acceleration and temperature. Deployment; Container waits for pressure altitude checkpoints. Descent; Container releases main descent parachute at +670 meters, and payload separation is at 500 meters. Landing / Post-Flight; Sensor data continues to be collected until landing on ground. Container and payload state diagrams are shown respectively:



Mission Summary

A CanSat is going to be launched in a rocket. This CanSat will contain two parts that are going to separate at a certain point in the air, both parts will collect telemetry. One part will have to free fall from 500 meters above and land a raw egg safely.



Acknowledgement

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